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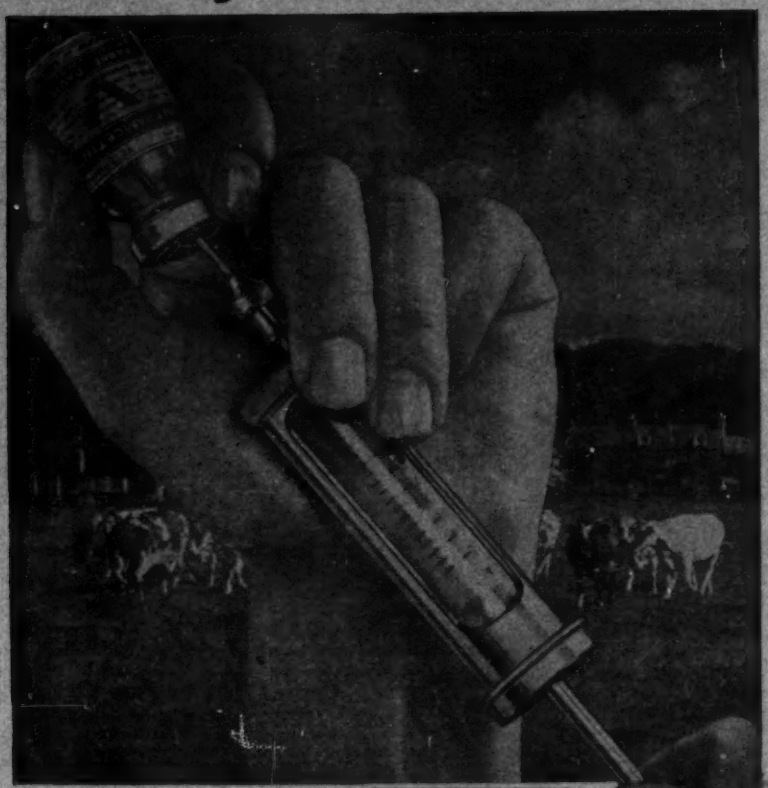

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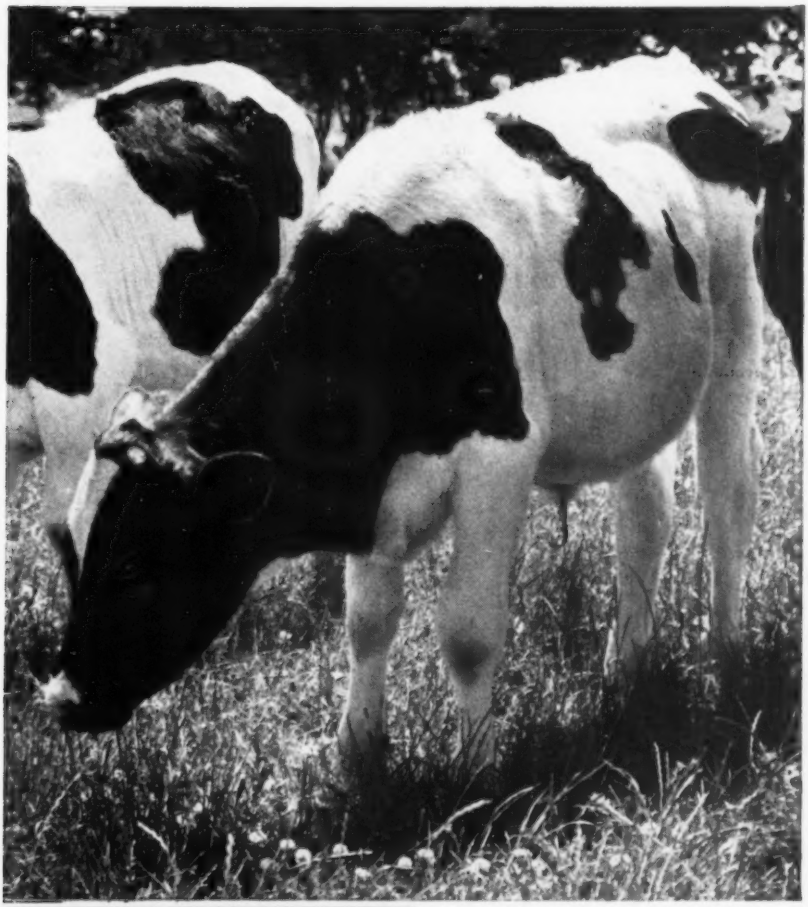

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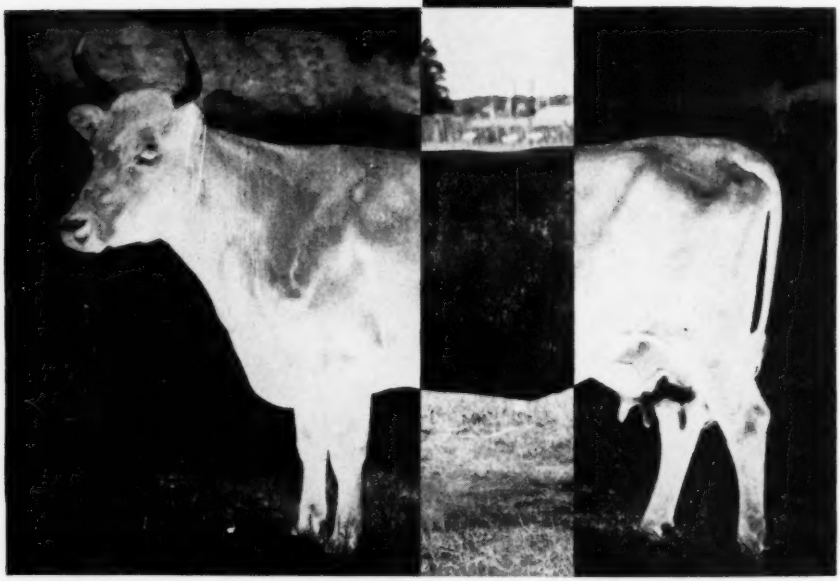

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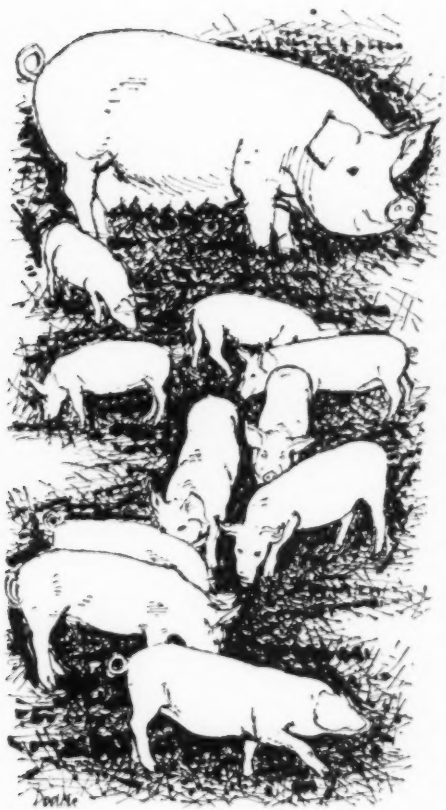

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OBSERVATIONS UPON THE GASTRO-INTESTINAL TRACT OF THE LIVING FOAL

By K. M. DYCE

Department of Anatomy, Royal Veterinary College, London.

The abdominal topography of the new-born foal does not appear to have been described in either the living or the dead subject. There are, of course, numerous accounts of the postmortem anatomy of the adult animal and several radiographic studies of the gastro-intestinal tract of older foals and of adult horses (e.g. Alexander & Benzie, 1951 : Müller, 1951 : Hill, 1952) ; but except in the first of these papers and for a few casual remarks elsewherein the literature (e.g. Alexander, 1954), there is no discussion of possible differences in visceral proportions and disposition in the neonatal and adult states. This neglect is the more striking since it is well known that there are important postnatal alterations in the topography and, for that matter, in the mechanics of the digestive organs of other animals, and of the ruminant in particular. For this reason, and also because of the difficulty of obtaining suitable subjects, it has appeared permissible to present the following brief account of the radiographic anatomy of the digestive organs of a single foal : it will be appreciated that observations derived from one individual must be treated with caution.

Material and Methods

The main observations were made upon a Shetland pony foal acquired when four days old. The foal presented anomalous development of the stifle joints but otherwise it appeared to be in good health. Dissection revealed no visceral abnormality. When in our care it was bottle-fed upon cow milk prepared according to the directions of Miller & Robertson (1959) and this feed was offered at four-hourly intervals from 7 a.m. to 7 p.m. : it was consumed readily. The experimental meal consisted of equal parts of the milk mixture and of a barium sulphate suspension (Micropaque — Damancy & Co.), and it was given in place of a normal meal. Feeding was continued according to the usual routine during the periods of observation.

The radiographic technique calls for no special comment. The exposure factors were in the region 65-70 pKv, 10-20 MAS, at 36″ FFD, and fast film and standard screens were employed. The foal was examined in the standing position and the minimum of restraint was used. It will be noted that movement mars certain of the plates. Films were obtained at regular intervals, in both lateral and ventral projections, but unfortunately it was impossible to continue to make observations through the night hours.

The principal study was made when the animal was five to six days old but a few additional films were obtained on the nineteenth day before it was sacrificed for reasons irrelevant to this enquiry.

Some reference is made to earlier work with mature animals of the New Forest breed and certain radiographs from this source are reproduced. These larger animals were anæsthetised in order that the respiratory excursions could be arrested during the periods of exposure but it is believed that this did not affect the general appearance of the organs: any possible effect upon their movements is outside the scope of this paper. Details of the anæsthetic and radiographic techniques employed with these subjects have been published elsewhere (Dyce, Jones & Wadsworth, 1952: Drury, Dyce & Merlen, 1954).

Observations

The Stomach

The stomach of the adult horse is notable for its small size and for its dorsal position in the abdomen (Fig. 1). Normally invisible in plain radiographs, following the administration of a contrast meal it is found immediately behind the diaphragm: its extent and its skeletal relations vary according to the volume of its content and with the phase of respiration. When distended the ventral part of the stomach reaches approximately to the junction of the middle and lower thirds of the abdomen while the dorsal extremity lies in contact with the abdominal roof. The long axis is generally inclined cranioventrally and the upper half of the cranial surface follows the contour of the diaphragm, being angled to accommodate the crus of this organ. The breadth of the stomach is generally less than half its vertical diameter but when it is grossly distended both surfaces become markedly convex and then the organ appears globular. In the lateral projection it is rarely possible to determine much of the conformation of the pars pylorica but an increased density overlying the ventral part of the body may indicate this portion: it is depicted with more clarity on the relatively rare occasions when it trespasses beyond the outline of the body.

The form of the stomach is demonstrated best in the dorsal view. The greater part of the organ is found to the left of the midline and on occasion only the immediate prepyloric section extends into the right half of the abdomen. More commonly the body overlaps the spine and the narrow pyloric limb of the stomach passes below the vertebrae and for some considerable way to the right; usually this part lies transversely but occasionally it lies obliquely. In this projection the saccus caecus naturally appears as the most caudal part.

The stomach of the neonatus showed the same general features as the adult organ, but in both projections it appeared to be sited more centrally within the abdomen (Figs. 2 & 3). In the lateral view it extended, when full, almost to the abdominal floor but even in these circumstances the saccus caecus scarcely reached within a shorter distance of the roof. As it contracted the stomach withdrew from the abdominal parietes, presumably towards the oesophageal attachment, and a wide gap intervened between the saccus caecus and the roof, presenting an appearance

very different from that observed in the adult (Fig. 4). In the lateral projection the shape of the stomach was subject to considerable variation and it appeared that when filling, it first enlarged in depth and it expanded transversely (Fig. 5) only when a certain limit had been reached.

In the dorsal view the more symmetrical position resulted in it remaining well clear of the lateral walls even following a feed sufficient to satisfy the animal.

The Small Intestine

The plates which shew the small intestine provide no features that call for detailed comment. The duodenum was only occasionally identified (Fig. 5) and the mesenteric coils varied considerably in position although they were mainly disposed in the anterior two-thirds of the abdomen. Apparently they often deny the large intestine any extensive contact with the right wall of the body. Sometimes segmental and peristaltic movements (Figs. 2, 4 & 6) could be identified.

The Caecum

The caecum of the horse occupies a large part of the right half of the abdomen and is in extensive contact with the body wall. It is conventionally described as consisting of a base, a body and an apex but it is difficult to obtain satisfactory radiographs since as a rule the caecal image appears to be continuous with those of neighbouring parts of bowel. A rather more definite radiograph of the adult organ than is generally obtained is reproduced as Figure 7 and depicts the caecum in a form different from that which is generally described. A very similar film has been the subject of a previous note (Dyce, 1956).

In the foal the organ was demonstrated readily, and in form at variance with the common description (Fig. 2). The upper part, or base, appeared to be particularly small and was separated from the roof of the midlumbar part of the abdomen by a considerable gap : successive exposures revealed that it was free to vary its position within relatively wide limits. The junction of the caecum with the right ventral colon was constricted for although this part of the bowel was never observed when full of ingesta sufficient agent generally adhered to the folds of mucosa to permit its identification. The caudal part of the base was prolonged to form the body and traced a curve whose caudoventral convexity carried it to the abdominal floor. The position of the lower part of the body, and of the apex, was not fixed and although usually this part ran forward, towards and across the midline, at times it diverged from this disposition and appeared to be directed towards the right flank. In the dorsal view the base of the caecum was found directly to the right of the midline and widely separated from the body wall (Fig. 6).

As one would surmise the caecal content was small in the milk-fed animal : on the whole the lumen was narrow and possessed a very irregular outline, at times almost completely partitioned by the haustral indentations, and very different from the turgid distended form typical of the adult organ.

The Large Colon

The complex disposition of the large colon hinders its radiographic demonstration. In the foal collections of gas outlined the various sections but the appearance and location of these was rarely sufficiently characteristic to permit a positive identification of the precise sections of bowel (Fig. 2). The same difficulty was experienced when a contrast meal outlined a limited section of the colon but the study of a series of radiographs permitted a more positive recognition of the various parts.

The first, or right ventral, limb of the large colon arose from the ventral aspect of the base of the caecum and continued towards the abdominal floor in contact with the body of this organ (Fig. 2). Characteristically it lay in contact with the right flank but on occasion it became separated from this by what was presumed to be coils of small bowel. Its anterior limit lay below the stomach and it flexed to continue as the left ventral colon. This portion was directed caudally and rose towards the abdominal roof: unfortunately the examination was interrupted during the period of filling of the pelvic part which, however, was discovered at the post mortem examination, when the animal was aged three weeks, to be disposed according to the classical descriptions. The outline of these two parts of the colon resembled that presented by the caecum, the haustral sacs usually being well delineated and, in places, almost independent: no constant feature distinguished the right and left limbs.

On the second day of the examination the anterior part of the left dorsal colon was observed to be passing in a cranio-ventral direction towards the hepatic flexure. This portion of the bowel was marked by rapid changing indentations which were at times very conspicuous. The hepatic flexure rested upon the abdominal floor in advance of the sternal flexure and it was related anteriorly to the liver (Fig. 9). Unlike the more sharply angled sternal flexure this part followed a gradual curve which possessed a transverse intermediate section (Fig. 8): on emerging from the bend it continued as the right dorsal colon still related to the liver and separated by this organ from the body wall. It had a very steep ascent which carried it to within a short distance of the abdominal roof. This part of the colon gradually enlarged in calibre and, since it was not marked by any conspicuous constrictions, formed a very prominent expansion. In the adult the last part of the right dorsal colon is described as possessing a transverse disposition but in the neonatus the lie of the gut was almost sagittal. The distinctive small colon appeared to arise from the medial aspect of this expansion and at times there was a short but well defined part of intermediate calibre.

The Small Colon and Rectum

The small colon of the adult animal is distinguished by the formation of the serially disposed haustra which mould the faeces into the familiar pattern. It lies mainly in the left posterior part of the abdomen (Fig. 10).

In the neonatus the coils of the small colon were disposed much as in the adult and it was not possible to determine which were the most proximal. It appeared (Fig. 9) that the moulding of the faeces was not effected until the ingesta

PLATE I

FIG. 1. Lateral view of the stomach of a recumbent, anaesthetised adult pony, 20 minutes after feeding.

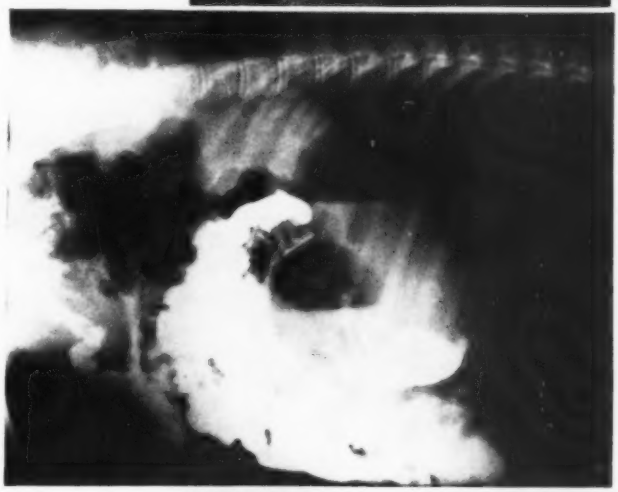

FIG. 2. Lateral view of the abdomen of foal aged 5 days, 6 hours after the experimental meal and 90 minutes after a further small milk feed. The large air bubble immediately behind the diaphragm and the accumulation of barium below this indicate the dorsal and ventral limits of the stomach. The pyloric extremity is faintly outlined. The caecum and right ventral colon are the other structures prominently depicted: a little barium adheres to the mucosa at the junction of these two parts. Elsewhere segments of the small intestine are visible, while accumulations of gas are contained in the large bowel.

FIG. 3. Ventral view of stomach of foal, aged 5 days, 2 hours after feeding.

PLATE II

FIG. 4. Lateral view of abdomen of foal aged 5 days, 4½ hours after experimental feed. The stomach is contracted. Most of the meal occupies the small bowel, some coils of which rest on the abdominal floor and appear of surprisingly wide calibre: the caecum and first part of the colon are very poorly depicted caudal to this level.

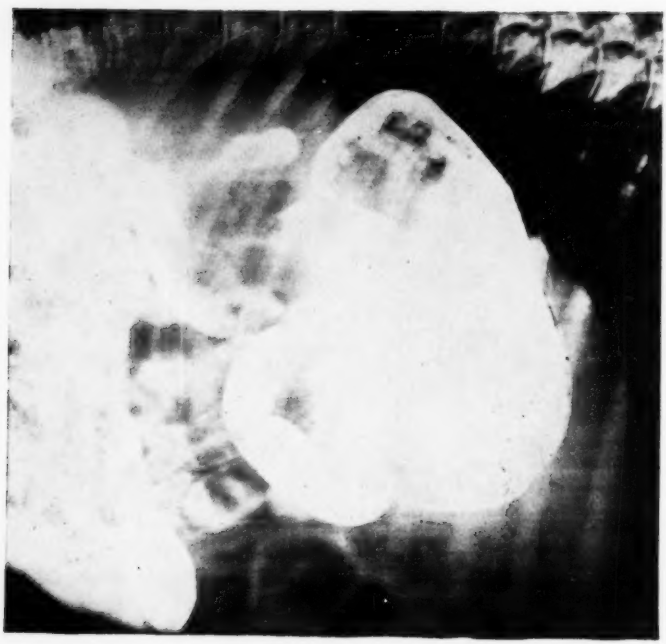

FIG. 5. Lateral view of stomach of foal aged 19 days, 1 hour after feeding. The composite shadow to the left of the picture is produced by the coils of small intestine and the caecum. The duodenum is visible centrally, climbing onto the base of the caecum.

PLATE III

FIG. 6. Ventral view of abdomen of foal aged 5 days, 7¼ hours after experimental feed. The caecum which is foreshortened, appears centrally, the wide caudal base overlapping the spine with the apex cranial and to the left. The haustrated parts of the gut are the right ventral colon and the sternal flexure. Coils of small intestine are also visible.

FIG. 7. Lateral view of caecocolic junction of recumbent adult pony. The continuity of caecum (dorsal and caudal in position) and right ventral colon is well shown.

PLATE IV

FIG. 8. Ventral view of abdomen of foal aged 6 days, 24 hours after experimental feed. The cranial part of the left dorsal colon, the hepatic flexure, the right dorsal colon, the origin of the small colon, the floating coils of colon and the rectum are prominent.

FIG. 9. Lateral view, 4 hours later. The right dorsal colon is well shown, as are coils of small colon. The haustrated left dorsal colon is less definitely portrayed.

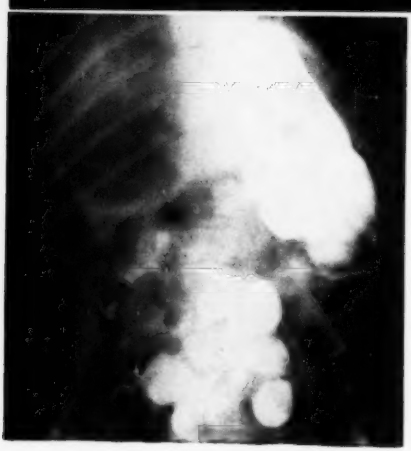

FIG. 10. Ventral view, 48 hours after the same feed. The right dorsal colon and the distal part of the small colon are displayed.

had reached the more distal half of this bowel, since long stretches did not depict the characteristic haustral succession.

The expanded rectum appeared to be of a more generous relative size than in the older animal. A wide band of air occupied this portion of the gut and extended forwards well in front of the pelvic inlet: cranioventrally it was continuous with the sacculated portion of the small colon (Fig. 9). It showed no lateral deflection in the dorsal view.

Discussion

The illustrations provide a fairly complete record of the visceral dispositions in this animal and some notion of the special characteristics of the neonatal period may be gained from their study if comparison is made with the radiographs in other publications and with the textbook figures. The description has been couched in very general terms. It would be simple to attempt to create an impression of precision by repeated reference to the fixed landmarks of the skeleton but such a procedure is out of place when dealing with organs that are constantly in motion and whose appearance reflects merely their activity and content at that moment.

The salient distinction of the gastro-intestinal tract of the neonatal foal appears to be the relatively narrow calibre and small bulk of the caecum and large colon. Although never displayed in their entirety, these parts together appeared to occupy a far smaller proportion of the abdomen than in the adult. Whether this was due to their yet undeveloped state or whether it reflected only their smaller content in the milk-fed animal cannot be stated with certainty. A relatively larger stomach is also evident in the newborn, although it appears to be less capacious than had been anticipated.

These differences in proportion naturally recall the situation observed in the newborn calf or lamb in which the abomasum dominates the abdominal topography and the rumeno-reticulum appears almost insignificant in comparison. The similarity is more striking when it is recalled that the large intestine of the horse subserves much the same function as the forechambers of the ruminant stomach, while the abomasum corresponds closely to the simple organ. In both species the alteration to adult proportions appears to be accomplished gradually and to be associated with, if not directly effected by, the change in the animal's diet. Certainly Alexander & Benzie's description of the organs in foals aged several months indicated an intermediate form of the gut at this age and they stressed the occurrence of profound alterations after weaning. It is at present impossible to say whether this change in form is due to the growth of the organ following the stimulus provided by the bulkier food or whether, being genetically predetermined, it would proceed independently of this. If the development of the ruminant stomach is a guide then it is likely that both factors are involved (e.g. Trautmann 1932).

Two or three other features are worthy of brief mention. First, the caecum, contrary to general experience, was well shown and it is interesting to note that its form corresponded to that already noted in the living organ of the adult (Dyce 1956)

and not to that with which one is familiar in the post mortem specimen. The present observations differ also from those of Alexander & Benzie in finding a prominent representation of the haustra of the large colon. Alexander & Benzie suggested that a clear-cut appearance of these segments was characteristic of the weaned animal, but in this subject, they were at times extraordinarily well developed at the early age of five days. Finally, it may be noted that in the neonatus the food appears to traverse the gut en masse, or at least more nearly so than in older animals, with the fortunate consequence that the successive segments are more clearly outlined and more certainly identified.

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A NOTE ON THE POSSIBLE ASSOCIATION OF *MUELLERIUS CAPILLARIS* WITH ENTEROTOXÆMIA

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During the winter of 1959 an outbreak of disease was studied on a fat-lamb property in the Margaret River district of south-western Australia. The circumstances surrounding this outbreak were of interest in that lungworm infestation and enterotoxaemia appeared together in a manner suggesting a close etiological association.

Ecological Considerations

The property concerned is typical of many of the small holdings in the district. It is situated within a narrow 40-50" coastal rainfall belt with the greater part of the fall taking place during the winter from May to September. The average winter minimum and summer maximum temperatures are 44°F. and 82°F. respectively. The country is gently undulating and irregularly covered with dense jarrah forest. Soils are generally deficient in trace minerals, especially copper and cobalt. Herbage begins to come away well during June, reaching its strongest growth in September as spring approaches ; it falls off as the warm dry weather of late spring and summer sets in.

The farm on which these observations were made runs along both sides of a sluggish creek with the fields rising gradually from it and forming the sides of a shallow valley. It is roughly divided into two 250-acre sections, each holding, in the winter of 1959, about 550 cross-bred Corriedale-Merino ewes and their lambs, at an average stocking rate of four sheep to the acre. About 900 lambs were dropped on this property and were between three and four months old when ewe deaths began in early September. Meteorologically, the winter of 1959 followed the usual pattern except that there were fewer wet days, and temperatures were slightly higher than normal. The pasture growth was quite heavy, especially in September, when it became very lush and rank, and consisted mainly of subterranean clover (*Trifolium subterraneum*), rye grass (*Lolium rigidum*), capeweed (*Cryptostemma calendula*), and volunteer annual grasses.

All the fields are top dressed each year with copper and all the sheep are given cobalt " bullets " and are provided with salt and mineral licks containing various trace elements. Rotational grazing is the main helminth control measure. Paddocks are occupied for five days at a time with a complete cycling in 35-40 days. Land snails are very numerous in this district.

History of the Outbreak and Clinical Signs

All but one of the losses, which began during the first week in September and continued sporadically until the middle of October, occurred in one of the two sections. The reasons for the localisation of the disease in this manner could not be determined as there were no apparent differences between sections and the sward was equally heavy and rank in both. The entire adult flock had been immunised on 1st June with Pulpy Kidney Toxoid and, while the affected group had been reimmunised on 7th September (*after* losses had begun), the other had received only the single injection.

A total of 20 sheep died, all of them two- and four-month ewes. Only two lambs were affected, both of whom recovered when treated with enterotoxaemia antiserum. Clinically, affected sheep could be divided into two groups. In the first, signs of disease were not seen, sheep being found dead and bloated. In the second, the affected animals initially showed nervous signs suggestive of enterotoxaemia, with rapid onset of prostration, mild tonic spasms, opisthotonus, salivation and grinding of the teeth. Death came in 24-48 hours after a comatose period. Only four or five sheep succumbed in this "sub-acute" manner.

Pathological Investigations

Four specimens were submitted to the Laboratory in the following order:—

(a) Living ewe of the "subacute type" sent in during the second week of the outbreak.

She was in good fat condition and milking well and was exhibiting typical toxic signs of this group. On post-mortem examination she showed, in addition to the lung changes to be described, serous fluid in the heart sac and both epi- and endocardial haemorrhages. The B.U.N. was moderately elevated (70 mg. per cent.) but other blood studies were normal including a serum calcium of 10.8 mg. per cent. (Blood sugar was not determined.) The lung tissue was infiltrated with thousands of yellowish-grey nodules, 1-3 mm. in diameter. They were hard and fibrous, sometimes gritty on palpation. Histologically, the lesions were typical granulomas made up of neurotic centres surrounded by epitheloid cells, foreign-body type giant cells and lymphocytes, and encapsulated by a prolific growth of fibro-blasts and collagenous material. Some of the granulomas contained lungworms (Fig. 1) and in some, eosinophiles were numerous. Other microscopic findings were moderate fatty metamorphosis of the liver, and mild tubular cell degeneration of the kidney.

(b) Ewe, dead about 10 hours, showing the advanced decomposition characteristic of enterotoxaemia and gaseous distension of the carcase and the intestines.

Despite this degeneration it was decided to study, in some detail, the parasites carried by this sheep. A moderately heavy infestation of adult worms, mainly of *Ostertagia* spp., as well as several thousand immature stages, was found in the abomasum, and more than a thousand fourth stage *Muellerius capillaris* larvae were digested out of the lungs.

(c) Liver, lungs, kidneys, abomasum and small intestinal contents sent in from a ewe from the otherwise unaffected mob.

PLATE V

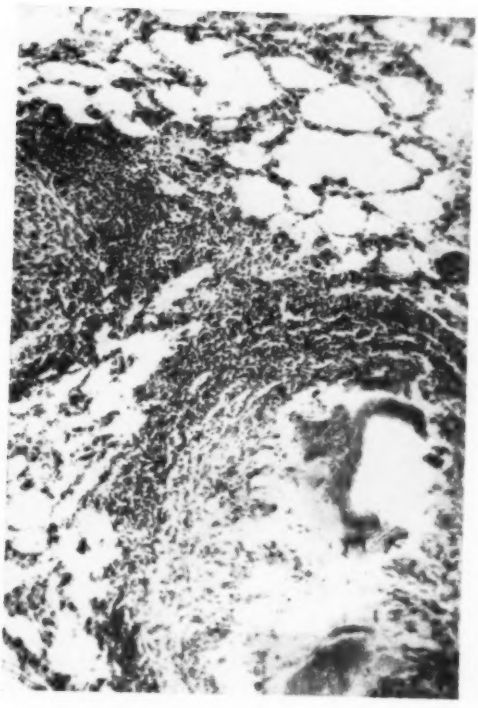

FIG. 1

Lung section showing *M. capillaris* and the nature of the cellular reaction surrounding the parasites. X300. H. & E.

She had shown the "subacute" signs discussed above and had been killed *in extremis*. The intestinal contents yielded extremely potent *Cl. welchii* Type D toxin. Grossly the lungs were studded with thousands of tiny greyish miliary lesions which microscopically gave the appearance of a very early stage of lungworm invasion, and consisted of interstitial collections of lymphocytes, macrophages and young fibroblasts with a slight deposition of fine collagenous fibrils. There was a generalised thickening of alveolar walls with these cell types, becoming more intense and conspicuous towards the pleural surfaces. Although no lungworm larvae were seen in the sections examined, about 1,800 fourth stage *M. capillaris* larvae were digested out. The kidneys showed coagulation necrosis and marked nuclear pyknosis of the cells of the proximal convolutes.

(d) Lungs sent in from a ewe dying during the fourth week of the outbreak.

The microscopic picture was essentially the same as seen in the lungs from (c) above. Once again no lungworm larvae were found in the sections, but an estimated 400 were recovered by pepsin digestion.

Discussion

It is suggested that the deaths in this outbreak were due to the absorption of the toxin of *Clostridium welchii* Type D. Environmental conditions were favourable for enterotoxaemia as the herbage was in a particularly rank stage of growth. The most forward and best-conditioned sheep were those chiefly affected, and the clinical signs and post-mortem changes were characteristic of this disease. Furthermore, the toxin was isolated on one of the two occasions that satisfactory diagnostic material was presented.

This opinion remains unchanged by the fact of the previous immunisation of the flock with specific toxoid. Watts (1959) has shown experimentally the great variation in immunising potency in different commercial brands of enterotoxaemia vaccines, and under practical field conditions it is sometimes found that one (or even two) injection is not sufficient to give complete protection against this disease. In the outbreak under consideration, it appears that the degree of protection afforded by the first immunising dose was inadequate in the face of the intensity of challenge mediated through the possible concatenation of heavy toxin production and severe lungworm invasion. Dogmatic assertion of the association of these two factors in the pathogenesis of this syndrome cannot be made, but the occurrence of clinical signs and death at a time when the lungs showed evidence of a considerable recent invasion of parasites, coupled with the "subacute" nature of the enterotoxaemic syndrome in some of the affected sheep suggests this association, and also suggests that the damage brought about by the migrating lungworms directly or indirectly facilitated the absorption, although not, of course, the elaboration, of toxin.

LaPage (1956) states that lambs under six months of age are usually not affected with this lungworm, although young lambs are more commonly affected with enterotoxaemia than are adult sheep. Therefore this age reversal of suspectibility to enterotoxaemia with its incidence virtually restricted to adults with acute

lungworm infestation further supports the idea that lungworm invasion was involved in the development of the syndrome seen on this property.

Rose (1958) has shown that the proportion of ingested *M. capillaris* larvae which become established in the lungs may be very low, ranging from 2 to 25 per cent.; if only comparable percentages became established in these sheep, the numbers which were ingested must have been exceptional, since Rose also points out that because the molluscan intermediate host usually is only lightly infested, massive infestations of *M. capillaris* are seldom acquired in a short time.

Gardner and Bennetts (1956) have drawn attention to the connection between enterotoxaemia and the bowel damage resulting from the penetration of the barbed hairs of Stinkwort (*Inula graveoleus*). Sheep losses from this form of enterotoxaemia can be quite heavy.

Marsh and Tunnicliff (1944) have reported the coexistence of coccidiosis and enterotoxaemia and believed that the protozoan infection predisposed to increased losses from the disease. Thomas and Downy (1956) have suggested that heavy infestations of *Moniezia expansa*, by retarding the passage of ingesta in the small intestine, may increase the susceptibility of sheep to enterotoxaemia. In a recent review on the subject, Stevens (1959) pointed out the probability that certain other diseases can help to precipitate enterotoxaemia and cited the occurrence of typical post-mortem lesions and the isolation of toxin from a significant proportion of a large group of lambs heavily parasitised with *Nematodirus* spp.

As coccidiosis, *Nematodirus*, *M. expansa* and Stinkwort all damage the small intestine in various ways and as lungworm larvae invade the intestinal wall with undoubted though undetermined amounts of damage, the same predisposition to enterotoxaemia may be effected by the lungworms as by the other causes of damage.

Carrol (1953) has stated that *M. capillaris* occurs in all states of Australia. In more specific statements on the distribution of lungworms in Western Australia *Strongylus rufescens* (*Prostostrongylus refuscens*) was first reported by Weston (1911). However, Seddon (1958) considers that all Australian references to this parasite refer to *Muellerius capillaris*. On the other hand, one of us (I.W.P.) found *P. rufescens* larvae in lambs from near Kojonup, which is about 120 miles east of the Margaret River district, and one male some 50 miles North-east of Perth. *Dictyocaulus filaria* is widely distributed in South-west Australia.

These facts suggest that anything which either damages the small intestinal wall or slows the rate of passage of the ingesta in the small intestine can predispose to enterotoxaemia. There is evidence that even phenothiazine can be a predisposing cause. In one small drenching trial with this anthelmintic on the Pentland Hills in Scotland, two weaners in a group of only fifteen died from enterotoxaemia, one on the day following and one on the sixth day following drenching (Parnell and Dunn, 1960).

SUMMARY

An outbreak of disease in adult ewes in South-western Australia is described. An association of enterotoxaemia with heavy infestations of fourth stage *M. cap-*

illaris was found and it is suggested that the migratory stage may have predisposed to clinical enterotoxaemia.

ACKNOWLEDGMENTS

Sincere thanks are expressed to Mr. A. W. Banks and Dr. A. Korthals of the Institute of Medical and Veterinary Science, Adelaide, South Australia, for the larval identifications; and to Mr. R. Harley, M.R.C.V.S., for facilitating the field studies.

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A NOTE ON THE PROPHYLACTIC VACCINATION OF WILD ANIMALS

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Rinderpest must rank very high among the various diseases that threaten directly the existence of wild ungulates in Africa. It is a disease that does not appear to have been enzootic in Africa always, and certain animals such as Buffalo (Syncerus caffer) and Eland (Taurotragus oryx) are susceptible to this epizootic in high degree. Recently, on clinical evidence, Rinderpest has been suspected to have occurred in Makuyuni Game reserve and elsewhere in Tanganyika.

Rinderpest is an acute, sometimes subacute, febrile, highly contagious and fatal disease of cattle, characterised by severe haemorrhagic catarrh of all mucous membranes of the body (Henning, 1949). It has not been observed in Britain since 1865. The plague was probably introduced along the East Coast of Africa in 1889, and was responsible at that time for destroying large numbers of indigenous wild ungulates. Buffalo are very susceptible to this disease and infected animals may travel long distances and spread the infection (Allan, 1934 ; Carmichael, 1938). On account of both their susceptibility and their ability to spread this disease, it appeared that the vaccination of the Parks buffalo should be considered. This has become a more urgent matter as the habitat of these animals is becoming more restricted each year and the possibility of their extermination through a major epizootic is increased thereby.

Until the importance of the larger indigenous wild ungulates, as a natural resource, has been evaluated, every precaution should be taken against these animals becoming extinct. It might be pertinent to mention that the Eland in Uganda, as well as other large artiodactyla such as the Roan Antelope (*Hippotragus equinus bakeri*) and Greater Kudu (*Strepsiceros strepsiceros bea*) are only found in areas outside the boundaries of the National Parks (Bere, 1958).

There are two National Parks in Uganda, both situated near its western border and extending over some one thousand nine hundred square miles. Throughout this area the African Buffalo (*Syncerus caffer caffer* and *Syncerus* c. *radcliffei*) are present in herds numbering several hundred. They live in a thriving state and no rinderpest epizootic has occurred for several years (Bere, 1958).

With our present technique it is necessary to immobilise the buffalo before vaccination, although simpler methods are under consideration. To our knowledge immobilisation of the African wild buffalo has not been effected before. A

PLATE VI

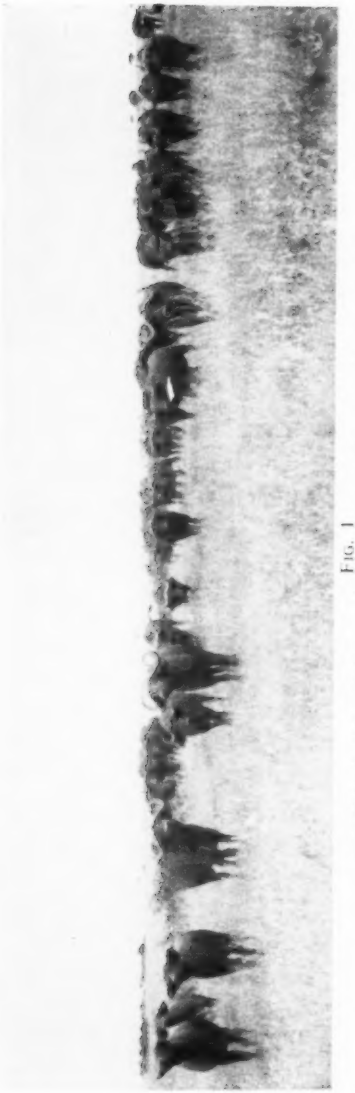

FIG. 1
A buffalo is selected from a herd of about fifty animals, and darted.

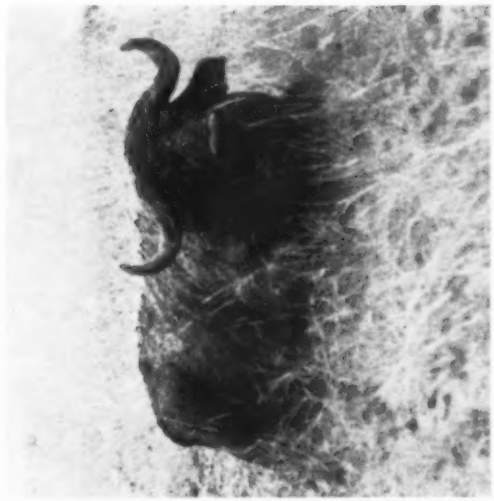

FIG. 3
The darted buffalo immediately after immobilisation.

FIG. 2
The darted buffalo leaves the herd and goes down.

PLATE VII

FIG. 4. The attenuated virus is injected into the caudal fold.

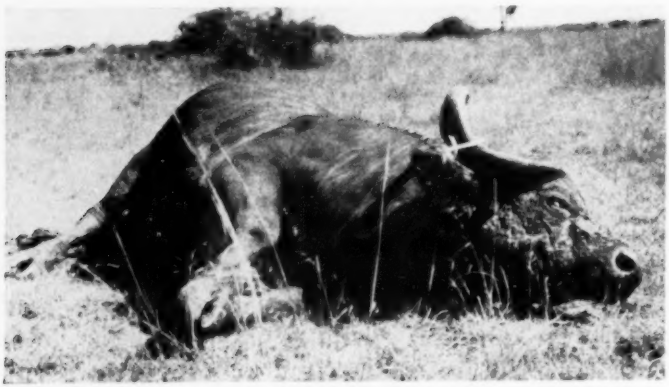

FIG. 5. A numbered tag is placed in one ear. A coloured plastic strip is placed in the other for short term recognition.

FIG. 6. The buffalo from Figs. 4 and 5 gets to his feet and prepares to charge. Time interval between Figs. 4 and 6 is approximately 20 minutes and the weight of the buffalo is estimated at 1,200 lb.

few trials with these animals outside the Parks have shown us that they are highly susceptible to paralysing drugs such as nicotine salicylate and succinylcholine chloride.

Immobilisation of buffalo in the Queen Elizabeth National Park was achieved with D. Tubercurarine chloride and with succinylcholine chloride (suxamethonium chloride), the latter having the advantages that the animal becomes immobilised in about ten minutes compared with some forty-five minutes with tubercurarine ; recovery is also much quicker and immobilisation is more thorough, especially with regard to the neck, and this facilitates earmarking. The dosage is, however, more critical. Nakamura III strain of lapinised rinderpest virus, produced by the East African Veterinary Research Organisation, was injected into the caudal fold on immobilisation. During transport, both before the addition of saline and afterwards, the virus was kept on ice in a four-litre thermos container. The virus had been divided previously into small portions, each of which was sealed in small tubes. Thus doses for only a few animals at a time were mixed with saline instead of the customary 40 or more. It has been established that immunity of the buffalo to rinderpest exists after injection of rabbit attenuated virus. Brown and Scott (1959) have injected captive African buffalo with lapinised rinderpest virus which induced a mild clinical response ; virus was recovered from the vaccinated buffalo and antibodies were formed. The animals vaccinated in the Park have now been kept under observation for some three months without untoward effects being reported.

The Uganda buffalo are smaller than those in Kenya and Tanganyika: the average weight of unselected animals shot being about 1,000 lb. Fully adult males weigh 1,200-1,400 lb. and the females about 1,000 lb. The males reach 1,000 lb. at four years (Longhurst, 1958). In Tanganyika the average weight of six males was 1,654⅜ lb. (Swynnerton, 1958). The Parks buffalo are not difficult to approach to a distance suitable for administering an immobilising dart. The methods whereby the automatic syringe is propelled to the animal have been described elsewhere (Buchner, Harthoorn and Lock, 1960). We calculate that some twenty to thirty could be vaccinated per day using a team of one driver, one shooter and two game scouts. In the unfortunate event of a rinderpest outbreak it is hoped that at the best we might prevent the virus from becoming a major epizootic in the Parks or at the least ensure that there would be survivors.

SUMMARY

The vaccination and prior capture through immobilisation of three wild African buffalo (Syncerus caffer) is described.

ACKNOWLEDGMENTS

We are grateful to Mr. René Bere, Director of National Parks, Uganda, for permission to carry out this pilot experiment of immobilising and vaccinating the buffalo in the Queen Elizabeth National Park and to the Warden, Major F. Poppleton, for his valiant assistance. Succinlycholine was generously given by Messrs. Burroughs Wellcome (East Africa) Ltd.

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THE ELEPHANT IN ANCIENT AND MODERN WRITINGS

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The most ancient writings on elephants are Sanskrit manuscripts, including those known as the Matanga-Lila of Nilakantha (The Elephant Sports), the Hastya-yurveda of Palakapya, the Tanjore manuscript, and the Kautilya Arthrasastra. The Matanga-Lila was translated into German by H. Zimmer in 1929 and was severely criticised by Franklin Edgerton in his English translation of 1931.

The latter author is very cautious in his opinions as to the antiquity of the manuscripts still preserved in India ; some of these may be copies of manuscripts long perished. Undoubtedly the original authors lived over 2,000 years ago, perhaps even earlier. According to Iyer (1937) some authorities think they were written about 2,000 B.C. Some have been edited in book form but not translated into modern languages (see Edgerton, 1931).

It is probable that the old Sinhala Ola (i.e. palm leaf) manuscripts edited by Deraniyagala (1952) were derived largely from the Sanskrit ones, but the care and treatment of elephants was well studied in the ancient civilisation of Ceylon. It is recorded that there were veterinary officers in the elephant establishment of the court of the Kings of Ceylon. Thus it may be that some of these ancient Sinhalese writings were original observations. Apparently not only the ancient Hindus of India were interested in elephants, but also the Tamils of South India, as there is preserved a great deal of Tamil poetry mentioning the animal. These Tamil writings have been compiled in a small booklet written partly in English and published by E. S. Varadarajaiyer in 1945 under the title "The Elephant in the Tamil Land."

In ancient days, elephants of the Asian race abounded in India and Ceylon and according to Deraniyagala (1955) extended as far West as Assyria and other Near East countries. They were hunted by the Kings of Babylon and Assyria and became extinct in those countries about 800 B.C. Later, they disappeared from Persia and Afghanistan and comparatively recently from the South of China.

At the present day, they exist in greatly diminished numbers in the jungles of Ceylon, South India, Bengal, Assam, Burma, Siam, Laos, Cambodia, Vietnam, Malaya, Borneo and Sumatra. Deraniyagala (1955) has described the characteristics of the races of elephants in those countries. The average size of full-grown adults varies as well as the possession of tusks and in colour. The old Indian and Sinhalese writers also classified them according to their intelligence, docility and longevity. Even to this day, there are recognised castes of elephants (see Sanderson, 1878, and Evans, 1901).

The Western peoples first came into contact with Asian elephants when Alexander the Great invaded Persia and defeated Darius, King of Persia, at the Battle of Arbela in 331 B.C. Darius had a few elephants in his army.

Four years later, in 327 B.C., Alexander invaded India and defeated Porus, King of Taxila, at the Battle of Hydaspis. Alexander captured the elephants of the Indian King and made use of them in his own army. A modern French historian, Armandi (1843) suggests that Alexander sent some of these captured elephants back to Athens to his old tutor, the philosopher Aristotle, who studied them and described their conformation and general physiology with great exactness in his treatise "De animalium."

After Alexander's death, one of his heirs, Seleucus Nicator, became allied through marriage with a great Indian King, Chandragupta, King of the Gangarides, whose capital city was Palibrotha, the modern Patna.

Chandragupta (called Sandracotta by the Greeks) gave his son-in-law a wedding present of 500 trained war-elephants. These were employed by Seleucus Nicator and his successors in their wars against their rivals, the Antigonides and the Ptoltmeys of Egypt. Several others of the petty kings who were heirs of portions of Alexander's Empire bought elephants from the Indians; one of these, Pyrrhus of Epirus, was the first to bring elephants of war into Italy in his war against the Republic of Rome, 280 B.C. The Romans were terrified at their first encounter with the strange huge beasts, but soon learned to deal with them by noise and fire; in later battles, the elephants caused more damage to the army of Pyrrhus than they did to the Romans, and Pyrrhus had to retreat to his native Epirus. Meanwhile, the Ptoltmeys of Egypt, jealous rivals of the Seleucids of Syria, had conceived the idea of employing African elephants as engines of war. They were unable to obtain any Asian elephants by the overland route and this forced them to explore the countries bordering on the Red Sea and even Ethiopia. They first established ports on the coast of the Red Sea, then persuaded the aboriginal peoples whom the Greeks called Elephantophagi (elephant eaters) to capture elephants for them. These were transported in barges up to a port near the modern town of Suez, then up a canal, and they then walked to Alexandria. The establishment of these ports on the Red Sea led to further explorations across the Arabian Sea and into the Indian Ocean. Eventually there were regular deep-sea voyages over to the coasts of India and Ceylon; various goods and coins were brought; various goods taken back (spices, skins, silks and, perhaps, even Asian elephants!). This mercantile marine was continued by the Romans and evidence of this trade has been found on the West coast of Ceylon and on both coasts of India.

The Ptoltmeys used their African elephants in at least one battle against the Syrians (Raphia, 217 B.C.), but it is recorded that the African elephants were routed by their Asian cousins.

Meanwhile, another nation far to the west of Alexandria was watching the rise of the Ptoltmeys with apprehension. The Carthaginians were descendants of a Semitic trading and seafaring race, the Phoenicians. Armandi suggests that the Carthaginians had heard of Ptoltmey's collection of Ethiopian elephants and

PLATE VIII

The various noble characteristics of the elephant.

Elephants in warfare between the Seleucids of Syria and Ptolimies of Egypt. Roman and Carthaginians. Romans and Syrians.

had decided to recruit their own elephant army. In those days, there existed the Mauretanian race of African elephant in the Atlas mountain regions. Indeed, Herodotus, the first historian of the West (400 B.C.) had mentioned that elephants abounded in the country near the Pillars of Hercules. These Mauretanian elephants were a smaller race than the Asian elephants and it is suggested that this fact led to the specific name "maximus" being given to the Asian elephant. The much later exploration of the central Africa showed that the elephants of Kenya and Tanganyika are much larger than any race of Asian elephant.

The Carthaginians under their successive generals, Hamilcar, Hasdrubal and Hannibal, employed elephants in their long drawn out and bitter wars against Rome. The most famous episode is, of course, Hannibal's crossing of the Alps in his last desperate attempt to vanquish Rome. It is recorded that he took thirty-seven elephants and that all except one perished in the icy mountains. However, no traces of their bones or tusks have ever been found and to this day it is a matter of debate as to the route which Hannibal followed. Those readers who are interested should read "Alps and Elephants" by Gavin de Beer (1955). From the Battle of Arbela in 331 B.C. to the victory of Julius Caesar over Scipio, father-in-law of Caesar's great rival Pompey, at Thapsus in 47 B.C., that is almost 300 years, may be termed the Elephant Military Era. Julius Caesar proved conclusively that elephants were useless against disciplined troops and, in fact, more dangerous to their own army than to the enemy.

The Romans had no use for elephants except as curiosities in their triumphal marches and as victims of brutal slaughter in the arena of Rome.

The use of elephants in war was recorded by many of the Latin writers, Livy, Polybius, Arrian, Appian, Diodorus the Sicilian, etc. These accounts have been summarised by Armandi (1843).

The use of elephants in war was revived by the later Persian kings, the Sassanides, in their wars against the Roman Emperor, Alexander Severus (233 A.D.) and continued for many centuries in countries such as India, Ceylon, Burma, Siam and other parts of Indo-China. In British India in the 18th and 19th centuries, elephants were employed by the Army as transport animals and when the teak industry of Burma and Siam was developed in the 19th century, great numbers of trained elephants were employed. British veterinary surgeons were employed both by the Army and the teak exporting countries. Some of them published books describing the care and maintenance of elephants and also dealt with treatment and diagnosis of disease (Gilchrist, 1851; Slym, 1873; Steel, 1885; Evans, 1901; Hepburn, 1918).

There have been several non-veterinary publications dealing largely or even solely with the elephant: Sanderson's "Thirteen Years Among the Wild Beasts of India" (1878), Ferrier's "Care of Elephants in Burma" (1947), Deraniyagala's publications (1951, 1955a, 1955b). Of the strictly zoological publications, that by Brehm (1915) in German is recommended by Edgerton as much more useful than any book written in English. During the past hundred years there have been innumerable articles by various scientists dealing with the anatomy, physiology, paleontology, parasitology of the elephant, both Asian and African. Most of these

have been listed by Halloran (1955). There have been comparatively few articles on bacterial, viral and protozoal diseases. We know from the veterinary publications mentioned and later work that elephants are susceptible to anthrax,, haemorrhagic septicaemia (pasteurellosis), surra (trypanosomiasis) foot and mouth disease tetanus, rabies, salmonellosis, *Fusiformus necrophorus* infection, staphylococcus and streptococcus infection. They are said to be resistant to rinderpest and there is no record of glanders, of epizootic lymphangitis, of gas gangrene or of botulism. There have been records of plant poisoning and of snake bite ; in zoological gardens and menagerie elephants there have been several cases of tuberculosis (human type bacillus) recorded.

Some mention must be made of the writings about elephants in the long period between the fall of the Roman Empire and the beginning of modern zoology and comparative anatomy. In this long period of time, about a thousand years, there were extremely few mentions of the elephant in Europe. A Saxon poet recorded in verse the gift of an elephant to the Emperor Charlemagne from the Caliph Haroun-al-Raschid, of " Arabian Nights " fame, in the year A.D. 801. It is recorded that this elephant, Aboul-abbas by name, died in A.D. 810.

Then over 400 years later Frederick II, on his return from the Holy Land in 1229, brought an elephant to Italy. Several years later (1254) King Louis of France, returning from the Crusades, brought one to France and then gave it as a present to Henry III of England. The arrival of this strange animal, the first ever seen in England, created great excitement and interest in London.

Emmanuel, King of Portugal, brought an elephant from India to Rome in 1514 and presented it to Pope Leo the Tenth. This animal, Hanno by name, was celebrated in verse and anecdotes.

Gyllius, a French savant, saw two elephants in Constantinople in 1550 and sent a description of them to the Cardinal of Armagnac. Justus Lipsius records that in 1562 a young elephant was sent from Spain by King Phillip the Second to Emperor Ferdinand the First of Germany.

The next record of an elephant in Europe is that of one in Nuremberg, Germany, in 1629, and some years later in 1633 a white elephant, the only one ever brought to Europe, arrived in Holland.

All these rare visitors to Europe are mentioned by Armandi (1843).

There are several other interesting publications, for example (1) "An anatomical account of the Elephant accidentally burnt in Dublin," published in London in 1682 by A. Moulin, (2) the curious complication written in Latin by Hartenfells (1723) entitled " Elephantographia curiosa " and, finally, " L'Histoire Naturelle de Deux Elephans Male et Femelle " by Houel (1801). This latter book is amusing because of the author's red-hot French revolutionary patriotism, his study of the elephants' reactions to music (especially to the revolutionists' marching tune " Ca Ira ") and his laughable speculations on the mode of copulation. Indeed, after reading this book one is tempted to believe that it was the inspiration for the famous joke about the French author who, when asked to write a book about elephants, composed a treatise entitled " Les elephants et ses Amours."

In recent years, the author who has achieved outstanding success in books about elephants is the late Lt. Col. Williams (" Elephant Bill," " Bandoola " etc.). There have been many other popular books, but most of them are on the shooting of elephants. There may be elephants in plenty in Africa for blood-thirsty or ivory-greedy hunters, but the Asian elephants, especially those of Ceylon, are in grave danger of extinction unless very firm action is taken to stop the slaughter by villagers on the edges of the jungles. The extermination of the Ceylon elephant would be a great tragedy as, even in the days of Alexander the Great, it was famous for its intelligence, size and valour.

Finally, mention must be made of the very attractively written book of K. Carrington (1958) entitled " Elephants." This gives a popular account of the paleontology of elephants and their relatives, an account of their distribution in the world and of their habits, breeding and feeding ; there is also a summary of their rôles in ancient and modern history.

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[These two books give numerous references to the ancient Greek and Latin writers who described Asian and African elephants.]

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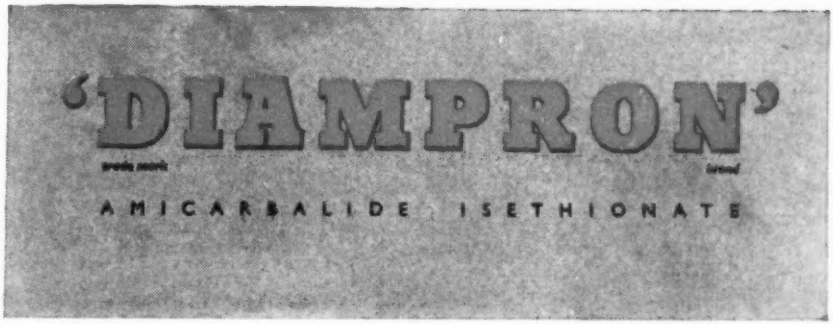

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REVIEWS

DIANA SETON—VETERINARY STUDENT. Joan Llewelyn Owens. London: Bodley Head. Price 8s. 6d.

One of the career novel series written around the student life of Diana Seton.

Diana had no contacts in the veterinary profession and she was attracted to a career in veterinary science because of her love for dogs and cats. A visit to a veterinary surgeon with an injured animal put the seal to her vocational urge. Having overcome some parental opposition she enrolled at the Camford Veterinary School. The details of the curriculum and her troubles and trials at the school will be familiar to veterinary surgeons and students but no doubt they will be of considerable interest to school children who aspire to be veterinary surgeons.

Of course the story has its sentimental vein and after many vicissitudes parental opposition turns to pride and Diana agrees to marry David Burke, a farmer's son, who introduced her to the animals of the farm and no doubt to other things also.

A pleasant readable story which will give the uninitiated some idea of the veterinary educational system.

TIERGEBURTSHILFE (VETERINARY OBSTETRICS). (Richter-Gotze.) 2nd Edition by G. Rosenberger and H. Tillman. Pages 904+19. Paul Parey, Berlin. DM.178.

This is a book, which is produced excellently and illustrated beautifully in black and white and colour. The first edition was published in 1950 under the names of two men who are internationally famous in the realm of large animal obstetrics. Both these men are dead, but it is good to see that tribute is paid to their eminence by the retention of their names in the title. In the new edition the scope of the book has been extended by the present editors with the collaboration of men equally renowned in the field of veterinary obstetrics.

In the foreword the editors express the hope that they have fulfilled the wishes of Götze in providing a work which would be an introduction to the student, a reference book for the practitioner and a foundation for the research worker. They can rest assured that this has been accomplished.

This book is much more comprehensive than its predecessor and consequently it is more than twice its size. This is reflected in the price (approximately £15) which is bound to be a restraining influence to would-be purchasers in this country.

The book commences with a brief history of veterinary obstetrics. The first part of the text deals with reproductive physiology, normal gestational changes, pregnancy hygiene, the manual and biological methods of pregnancy diagnosis, normal parturition and the puerperium. Then follows a description of the pathological conditions which may occur during pregnancy. These include developmental errors, diseases of foetal membranes, metabolic diseases and infectious abortion. Three hundred pages are devoted to dystocia. This part of the book is an exhaustive treatise on the practical aspects of dystocia, particularly embryotomy but Caesarean section has not been neglected. Finally, we have the pathological conditions of the puerperium, uterine prolapse, retention of foetal membranes, bacterial and metabolic diseases. Diseases of the newborn and sucking animal are covered well and the legal aspects of veterinary obstetrics complete a book which will rebound to the credit of its editors and contributors. One could perhaps sum up this book by saying that nothing appears to have been omitted. References to the literature are numerous and, since many

of them refer to work reported in the English language, it becomes a useful reference book on that score alone. A detailed review of this work is virtually impossible because of the mass of detail.

In view of the cost and the fact that all species are included, the editors might with advantage sectionalise the book into two volumes. The chapters dealing split the book into two volumes with advantage. The chapters dealing with dystocia could be abbreviated. Too much emphasis is given to the embryotomy section.

The publishers can be congratulated on the magnificent manner of production.

ANTIBIOTICS IN MEDICINE. Edited by Professor L. P. Garrod. (*British Medical Bulletin*, Volume 16, Number 1, January 1960.) London. The Medical Department, The British Council. Price 20s.

Professor Garrod has produced this excellent symposium with the help of 18 distinguished contributors. Fifteen sections deal with different aspects of the subject. Two general contributions are concerned with the principles of therapeutic use and the laboratory control of antibiotic therapy. There are clinical contributions on the prophylactic use of antibiotics in medicine and surgery, the chemotherapy of tuberculosis and the treatment of bacterial endocarditis. Two sections deal respectively with laboratory uses and the search for new antibiotics. The remaining contributions are concerned with chemistry, pharmacology, toxicity and the problems of resistance. As one expects from the British Medical Bulletin, all these contributions are of a very high order.

This symposium aims to provide the reader with well ascertained information on which he can base his own opinion. The rational use of antibiotics depends upon a fundamental knowledge of their properties and limitations. While this publication is designed for physicians and surgeons it is of general interest to all who are concerned with antibiotics.

AN INTRODUCTION TO PHARMACOLOGY. By J. J. Lewis, M.Sc., Ph.C. (1960). Edinburgh and London. E. & S. Livingstone Ltd. Pp. xii + 826. Price 55s.

The author is Senior Lecturer in Experimental Pharmacology at the University of Glasgow. He is to be congratulated on the production of a first-class textbook.

Many pharmacology textbooks deal with therapeutics also; these are not always satisfactory as the pharmacologist and the physician are interested in different aspects of the subject. This book is true to its title. It deals with the elements of pharmacology and concentrates upon the site, mode and type of drug action. Attention is paid also to the chemical structure of drugs and its relation to pharmacological action.

Unlike some pharmacologists, the author is just as interested in chemotherapy as he is in other branches of the subject and, of the 36 chapters, 12 are devoted to chemotherapy.

This book will be of value not only to science students studying experimental pharmacology, but to medical and veterinary students also.

CONTAMINATION OF WHOLESALE MEAT SUPPLIES WITH SALMONELLAE AND HEAT-RESISTANT CLOSTRIDIUM WELCHII. Betty C. Hobbs and J. Greenwood Wilson, *Monthly Bulletin of the Ministry of Health and the Public Health Laboratory Service*, December, 1959, Vol. 18.

Owing to the fact that, in 1956, samples of imported frozen boneless veal were found to contain *Salmonella typhimurium*, an investigation was undertaken, which extended over three years, for the purpose of ascertaining the incidence of *Salmonella, Cl. welchii* and coliform organisms in boneless meat and carcase meat.

The most striking facts were found to be the difference between the percentage of contamination found in boneless meat (of all types from different exporting countries) and that found in carcase meat from similar sources.

in the case of salmonellae, 10.3% were posotive in boneless and 4.3% in carcase meat. The difference was even greater for *Cl. Welchii*, 10.5% as compared with 1.5%. Plate and coliform counts on a small number of samples were variable and, even when high, did not necessarily indicate salmonellae contamination. Conversely, salmonella organisms were found in the absence of faecal coliform bacilli, and in samples with low colony counts.

It is suggested that transportation, particularly when animals are deprived of water and food, may result in carrier animals developing septicaemia. It has been observed that salmonella typhimurium infection in young calves has increased recently in South-east England. This organism may remain viable in water, pasture and faeces for from 4-28 weeks and it is thought that birds and vermin may become infected by food or water contaminated by sick farm animals.

A complicating factor is the part played by animal feeding stuffs and fertilisers. In a recent survey of 1,262 samples of feeding stuffs and fertilisers, 295 were positive for salmonellae (88 serotypes being recognised).

Recent research sponsored by the Public Health Laboratory Service Food Investigation Committee showed that a frequency of 0.4% of salmonellae in the gut of healthy pigs at time of slaughter became 4.9% in sausages made from the carcases of pigs. Presumably lack of effective hygienic measures at slaughter and during manufacturing accounted for this increased incidence. Similarly, the increase in the figure for salmonellae for boned out, as compared with carcase meat, may be due to the human factor.

There is risk of survival of salmonellae in pies and cooked meat subjected to irregular heat in certain ovens whilst organisms may be transferred from raw to cooked products. Similarly, contaminated raw meats may be a potential source of danger to otherwise healthy meat if exposed together in retail shops, etc. Irradiation with γ-rays has been used successfully for the sterilisation of egg products, on a small scale, and might possibly be used eventually for meat and other foods.

It is considered that large-scale investigations by public health and veterinary workers are necessary to trace the source of contamination on the farm and from farm to slaughterhouse.

PIG BREEDING, RECORDING AND PROGENY TESTING IN EUROPEAN COUNTRIES. *FAO Agricultural Studies* No. 44. 128 pages. Price 5s.

This is one of a series of publications of the Food and Agriculture Organization. Initially it discusses the aims of pig breeders in the different European countries and the various voluntary and official organizations associated with pig production. Then, long chapters are devoted to progeny-testing procedures in the different countries, and to assessment of slaughter quality, and finally there are

shorter sections on the utilization of the results of progeny-testing procedures in pigs and "Other Methods of Pig Breeding." This last chapter is the only one that has any immediate bearing on current policy in this country.

The publication embodies the results of numerous questionnaires and contains a mass of factual information and well-set-out tables and graphs. It is an encouraging example of the international co-operation which can be developed through organizations such as FAO, but its interest to readers in this country will be limited to those who are specialists in pork and bacon production.

NEUROLOGIC EXAMINATION OF THE DOG. By John T. MacGrath. 2nd edition. London: Kimpton. Price 52s. 6d.

This book, now in its second edition, deals with the neurologic examination of the dog in great detail: such detailed examination is not usually requested by the client, nor feasible for the veterinary surgeon, in this country, except when the latter is called in as a consultant. The first nine chapters deal with the neurologic examination, beginning with the method of taking the history of the case and concluding with examination of the cerebrospinal fluid. The remaining twelve chapters deal with the nervous diseases of the dog including metabolic and toxic disorders. There is a bibliography of more than 200 references.

The first few chapters include some of the relevant anatomy and physiology and these parts are written clearly and illustrated well with diagrams when necessary; inevitably, the subject has been over-simplified, and points such as the interdependence of different parts of the brain have not been clearly explained, but in general this part of the book is good.

The detailed examination described in the first nine chapters would not be of great practical value to veterinary surgeons in practice, for the simple reason that, in general, even if the site of the lesion is located, there is no effective treatment. However, this is a sign of the lack of veterinary knowledge in the field of neurology, and books such as this one would be of assistance to those doing fundamental research in this field. Some of the methods of examination suggested, such as "dropping the animal upside down from a height" (p.79), would not meet with the approval of owners in this country. The author gives the impression that definite results can be obtained from many tests, such as the electro-encephalogram, which in fact seldom give unequivocal results even in human medicine.

The second half of the book is very systematic in its approach, and contains a number of good photographs of live and post-mortem material, and interesting case histories. The author hopes that the book will interest research workers and veterinary students, as well as the small animal practitioners for whom it is primarily intended. In this country its main appeal is likely to be to research workers, and so it is unfortunate that the bibliography contains numerous inaccuracies: references mentioned in the text are often omitted from the bibliography or appear under the wrong chapter, names are mis-spelt and the year given in the text does not always correspond with that in the bibliography.

When nature comes up with the answer...

As a science, veterinary medicine has come a long way since the days of the ubiquitous drench. The veterinary surgeon now has at his disposal a large armoury of modern weapons — including antibiotics and the sulphamezanine drugs—with which to fight specific diseases. However, it often happens that the simplest remedy still lies in one of Nature's own contributions to health—Cod Liver Oil.

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